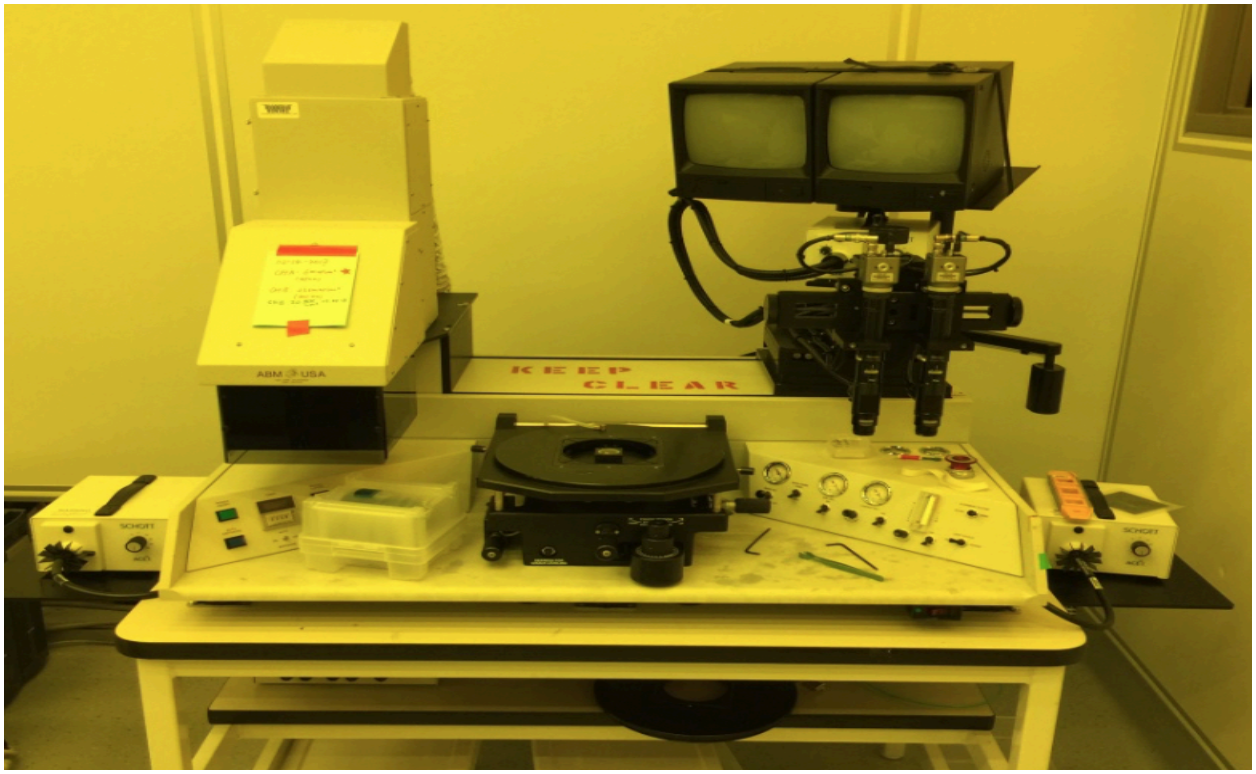


This document describes the standard operating procedure (SOP) for the ABM Mask Aligner and Exposure System (MA) at the University of Houston Nanofabrication Facility. An SOP serves as a foundation for initial training and ensures that the instrument can be operated correctly, by everyone, the first time. To minimize user error, please:

⚠ **Do not perform any procedures without prior training from a staff**

⚠ **Do not try to fix or circumvent a problem with the instrument**

⚠ **Report problems with the instrument to a staff**

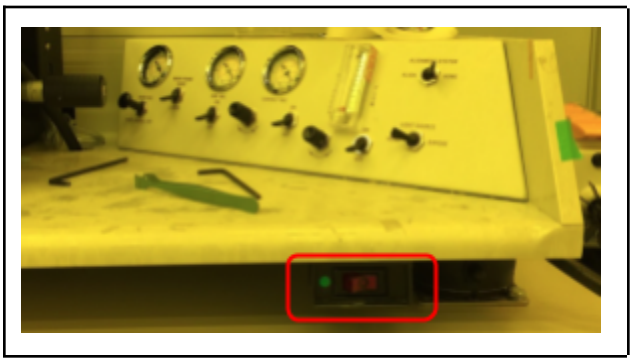
This SOP describes the basic operations of the Mask Aligner and Exposure System such as exposure and alignment.

SOP: ABM Mask Aligner

Exposure

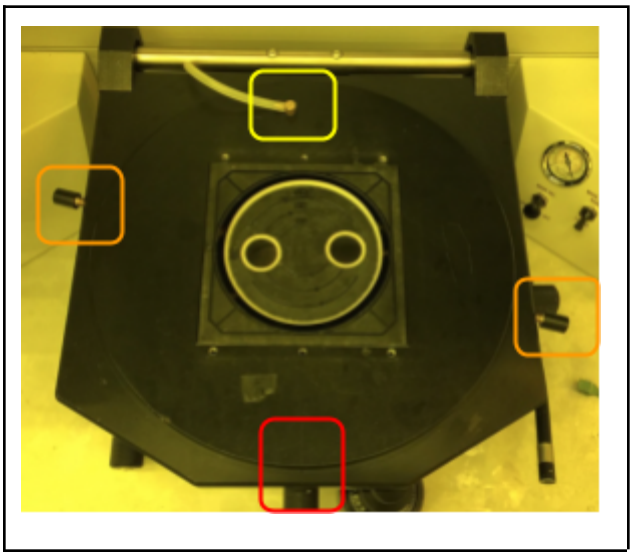
This instruction is for a 5”x5” mask and a 4” wafer sample. A variety of Mask Holders and Chucks are available to accommodate other mask and sample combinations.

Step 1: Turn on the Instrument



- Flip the switch to turn on the instrument

Step 2: Confirm the 5” Mask Holder is installed

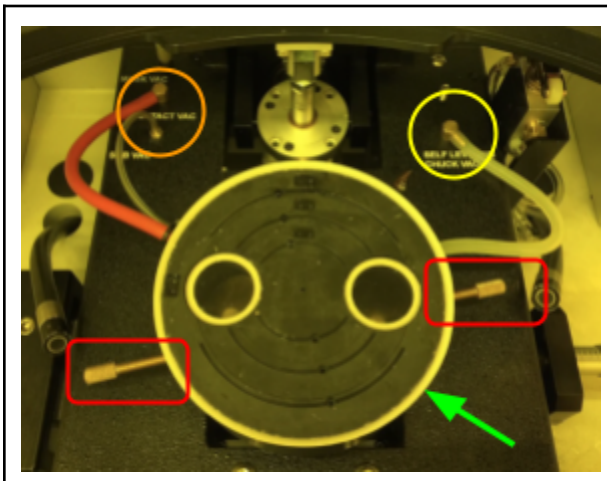


- Confirm the etched line on the mask holder is aligned with the mask frame
- Confirm that the (2) set screws are tight
- Confirm that the mask vacuum line is connected

Step 3: Raise the Mask Frame

- Flip the MASK FRAME switch to RAISE

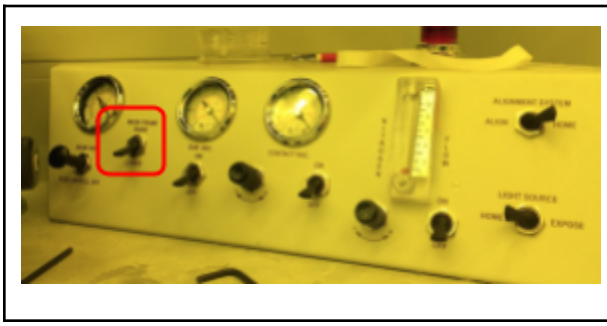
Step 4: Confirm that the 4” Chuck is installed



- Confirm the (2) set screws are tight
- Confirm the contact vacuum and substrate vacuum lines are connected
- Confirm the self leveling chuck vacuum is connected
- Confirm the white collar ring is not folded

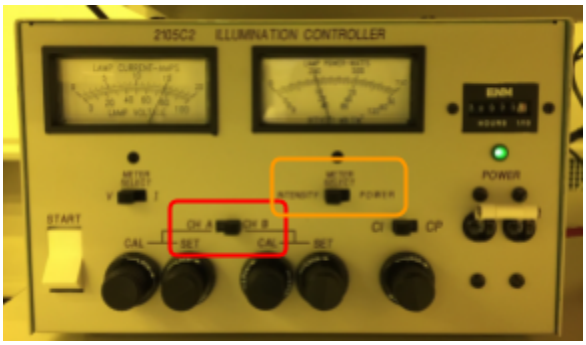
i *This chuck can be used with smaller samples*

Step 5: Lower the Mask Frame



- Flip the MASK FRAME switch LOWER

Step 6: Configure the Lamp Power Supply Display



- Slide the Channel switch to select CH A or CH B
- Slide the METER switch to select INTENSITY

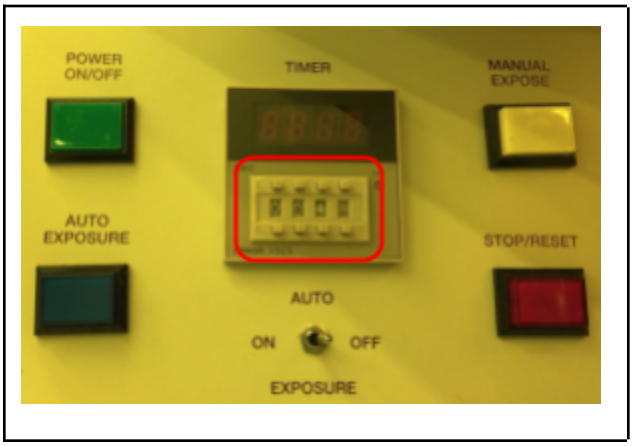
- *CH A is i-line or 365 nm*
- *CH B is g-line or 436 nm*
- *The choice of CH A or CH B depends on the photoresist*

Step 7: Read the Lamp Intensity

- Read the calibrated lamp intensity on the exposure module

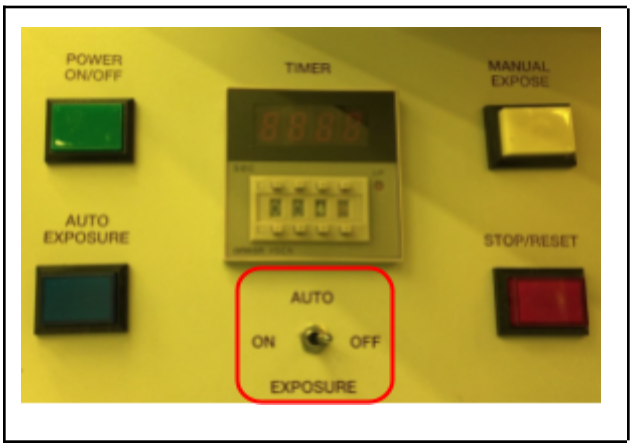
- *The lamp intensity is calibrated each time a new lamp is installed*
- *The power supply uses sensors and feedback to produce a constant lamp intensity*

Step 8: Set the exposure timer



- Calculate the exposure time
  - time = dose/intensity
  - The exposure time for a dose of 80 mJ/cm2 at a lamp intensity of 20 mW/cm2 is 4.0 seconds
- Set the expose timer

Step 9: Turn off auto exposure

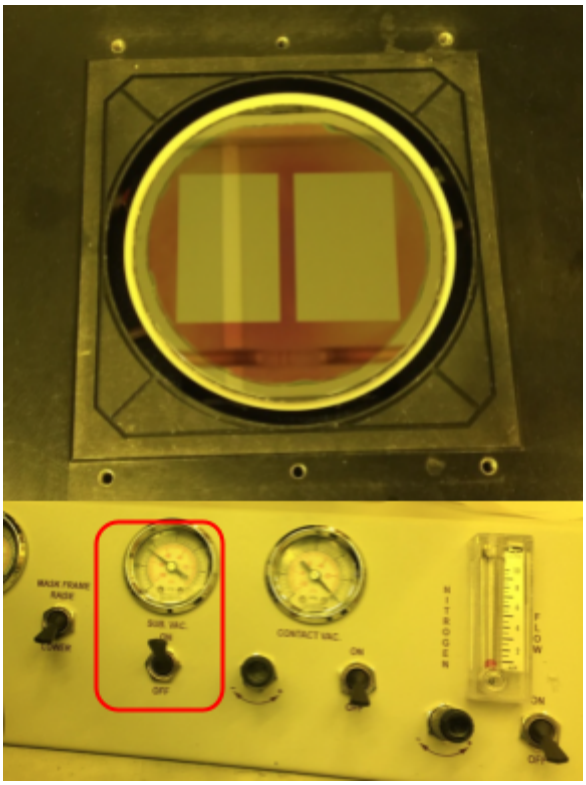


- Flip the AUTO EXPOSURE switch to OFF

Step 10: Lower the Chuck beneath the Mask Plane

- Turn the bottom Z knob clockwise to lower the chuck beneath the mask plane
- Confirm by looking at the chuck and mask holder at a glancing angle

Step 11: Place a sample on the Chuck



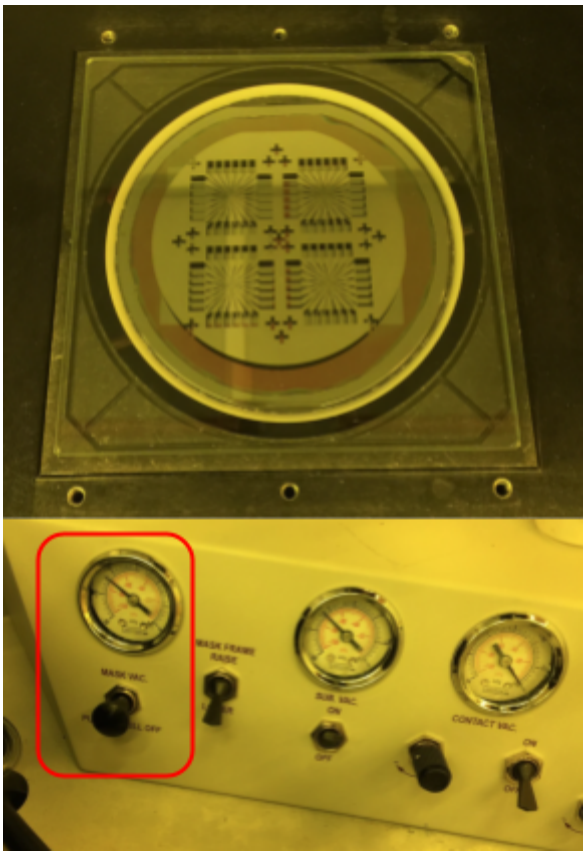
- Place a sample centered on the chuck
- Flip the SUB. VAC. switch ON

i *The substrate vacuum gauge should display a negative pressure*

i *Samples that do not cover all the vacuum holes on the chuck will show weaker vacuum pressure*

- Use a tweezer to push on the sample to confirm that it is secured

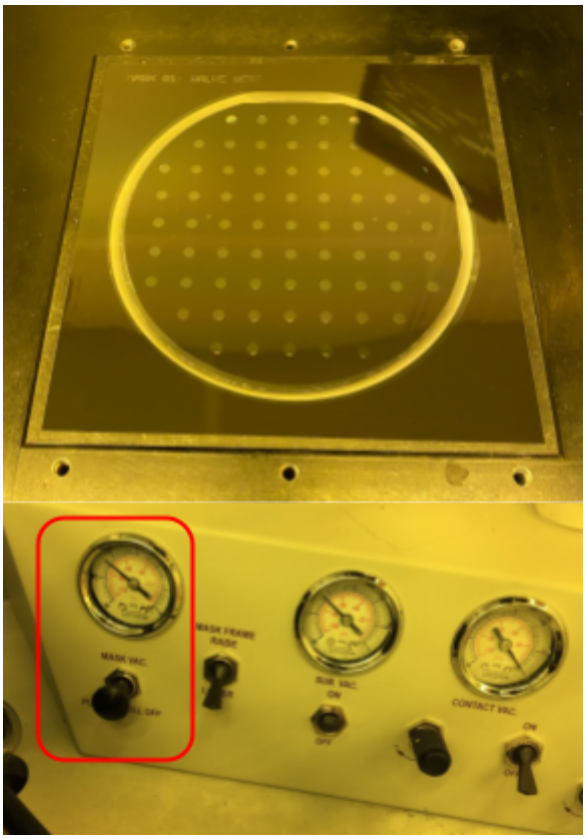
Step 12A: Place a Glass Mask on the Mask Holder



- Place a 5”x5” mask on the mask holder
- **Make sure that the Chrome side of the mask is facing down**
- Align the mask to cover all the vacuum lines
- Push the MASK VAC. button
- Confirm the vacuum pressure is stronger than -20 inHg

i *You may have to reposition the mask to achieve strong vacuum pressure*

Step 12B: Place a Film Mask on the Mask Holder

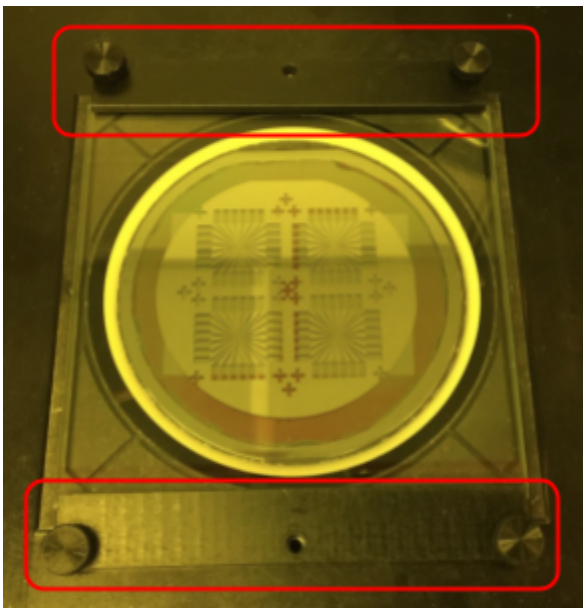


- Place a 5”x5” film on the mask holder
- **Make sure that the Ink side of the mask is facing down**
- Align the mask to cover all the vacuum lines
- Push the MASK VAC. button
- Confirm the vacuum pressure is stronger than -20 inHg
- Place a 5”x5” Clear Glass Plate on the mask

i *You may have to reposition the mask to achieve strong vacuum pressure*

i *The Clear Glass Plate is ⅛” thick borosilicate*

Step 13: Brace the Glass Mask or Clear Glass Plate



- Brace the mask with (2) angle brackets and (4) set screws

i *Bracing the mask can provide stronger contact pressure*

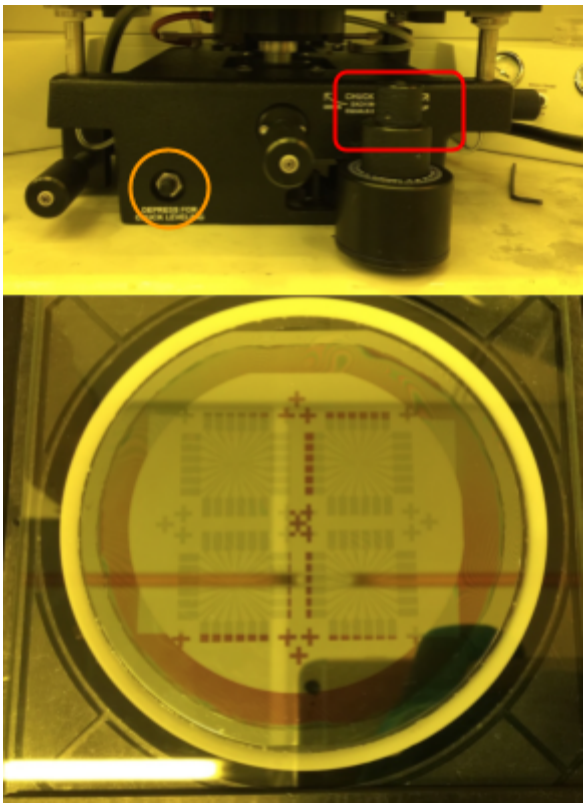
⚠ **Excessive contact pressure can break the mask**

Step 14: Turn On Nitrogen

- Flip the Switch Up to Turn On Nitrogen Flow
- Adjust the flow rate to 10 SCFH

i *Nitrogen flow counters the chuck vacuum to avoid premature contact*

Step 15: Planarize the Chuck



- Turn the top Z knob counterclockwise to raise the chuck until the Z knob feels loose
- Press and hold the CHUCK LEVELING button
- Wait 3 seconds
- Release the CHUCK LEVELING button

i *The chuck must press against the mask with sufficient force for chuck leveling to succeed*

i *The top Z knob is calibrated to disengage when the sample touches the mask with a certain amount of force*

Step 16: Establish Moderate Contact

- Turn the top Z knob counterclockwise to raise the chuck until the Z knob feels loose

i *Interference patterns will appear when the sample and mask are in contact*

Step 17: Establish Vacuum Contact

- Flip the switch to turn on CONTACT VAC.
- Wait for the Contact Vacuum pressure to stabilize

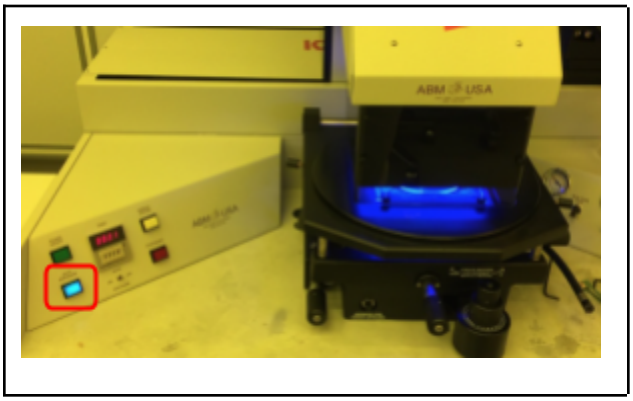
i *Contact Vacuum is typically less than -10 mmHg*

Step 18: Move the exposure module over the sample

- Flip the LIGHT SOURCE switch to the EXPOSE position
- Wait for the Expose Module to stabilize in position

i *The expose module will move directly above the sample*

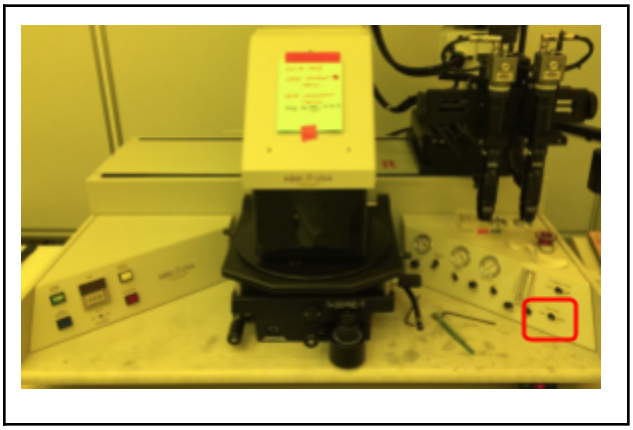
Step 19: Run the exposure



- Press the AUTO EXPOSURE button
- Wait for the exposure to complete

i *The sample will be exposed to UV light while the timer is counting*

Step 20: Move the exposure module back to the home position



- Flip the LIGHT SOURCE switch to the HOME position

Step 21: Turn off contact vacuum

- Flip the CONTACT VAC. switch to the OFF position

Step 22: Lower the chuck

- Turn the bottom Z knob clockwise to lower chuck

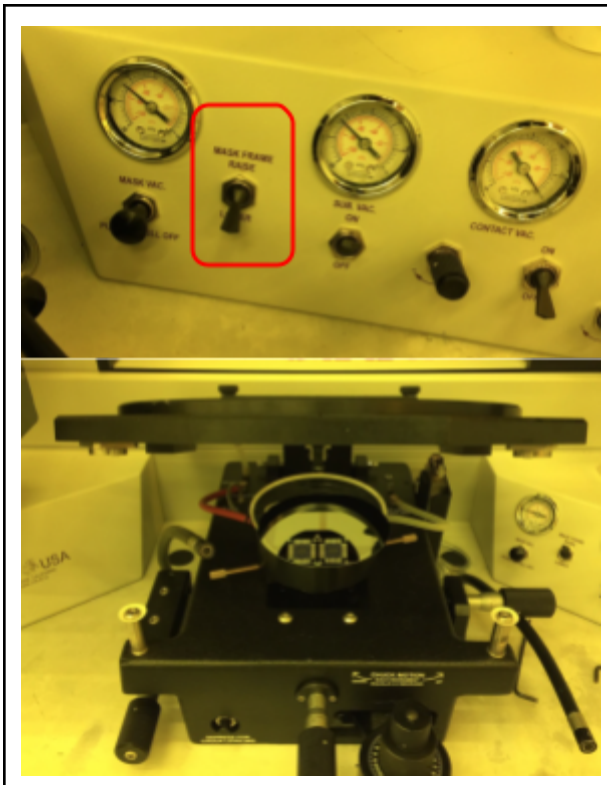
i *The sample should detach from the mask*

Step 23: Turn Off Nitrogen

⚠ **Forgetting this step will deplete the N2 Supply**

- Flip the Switch Down to Turn Off Nitrogen Flow

Step 24: Raise the mask frame



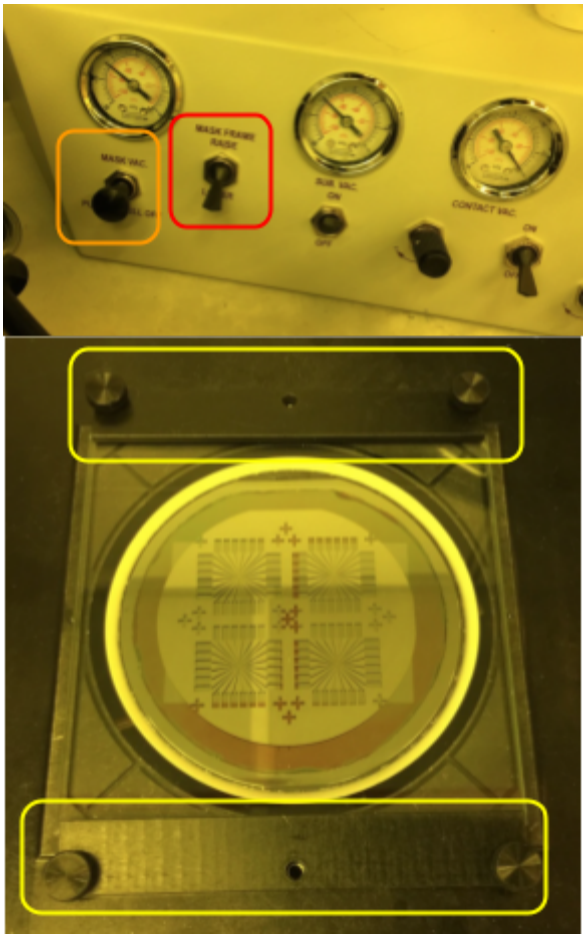
- Flip the MASK FRAME switch to RAISE

i *This allows you to swap the sample without removing the mask from the frame*

Step 25: Remove the Sample

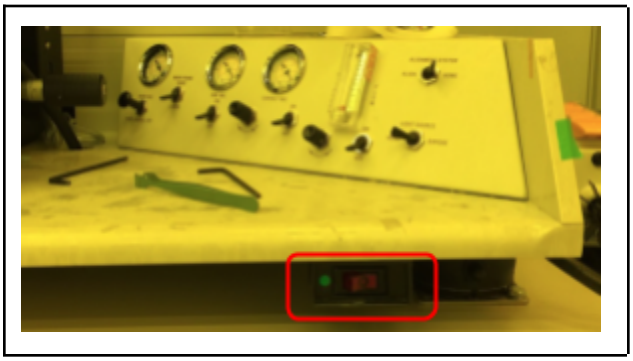
- Flip the SUB VAC. switch to OFF
- Remove the sample
- i *Perform another exposure by loading a new sample and repeat from Step 15*
- Flip the NITROGEN FLOW switch to OFF

Step 26: Remove the Mask



- Flip the MASK FRAME switch to LOWER
- Push the MASK VAC button
- Unfasten the mask brace
- Remove the mask

Step 27: Turn off the instrument



- Flip the Switch to Turn Off the Instrument

Alignment (Frontside)

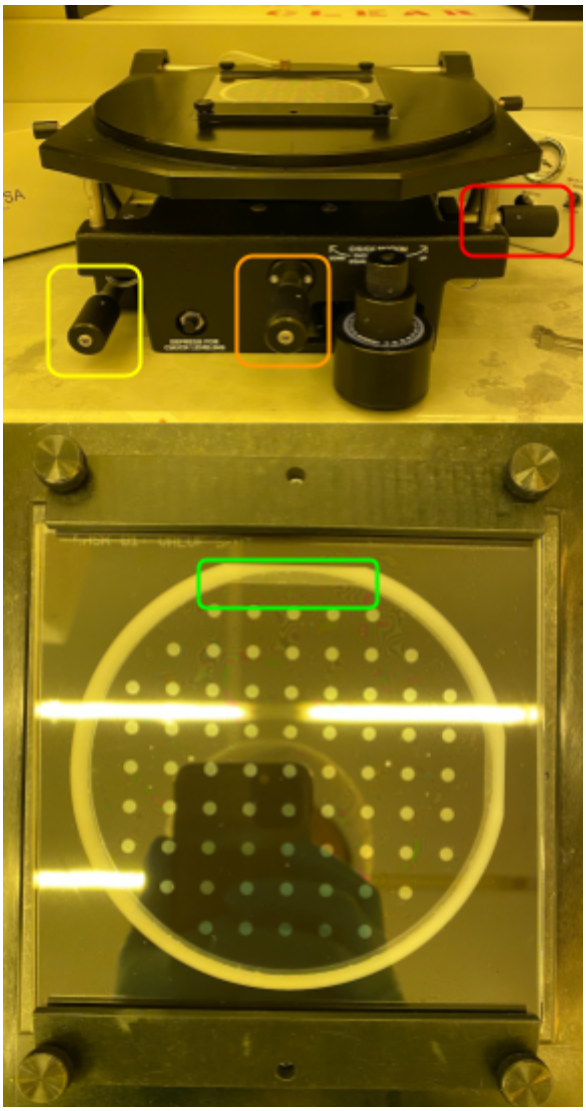
Alignment can be performed easily in under 5 minutes when the Mask is designed properly.

Step 1: Perform Exposure Steps 1 to 16

Step 2: Establish a 100 µm Gap

- Turn the bottom Z knob clockwise ½ a turn to lower the chuck by 100 µm

Step 3: Coarse Align Wafer to Mask



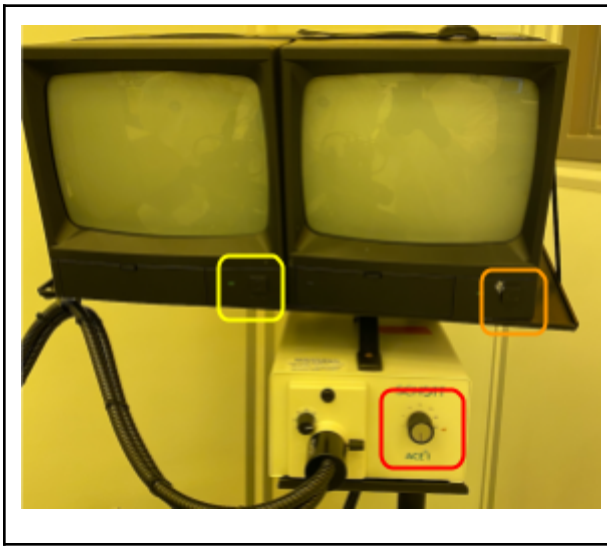
- Turn this Knob to Move the Wafer along X
- Turn this Knob to Move the Wafer along Y
- Turn this Knob to Rotate the Wafer
- Adjust the Wafer X, Y and Rotation to Align it with the Mask

i *This Mask is designed to facilitate coarse alignment. The Wafer will be barely visible when aligned.*

Step 4: Move the Alignment Module over the Mask

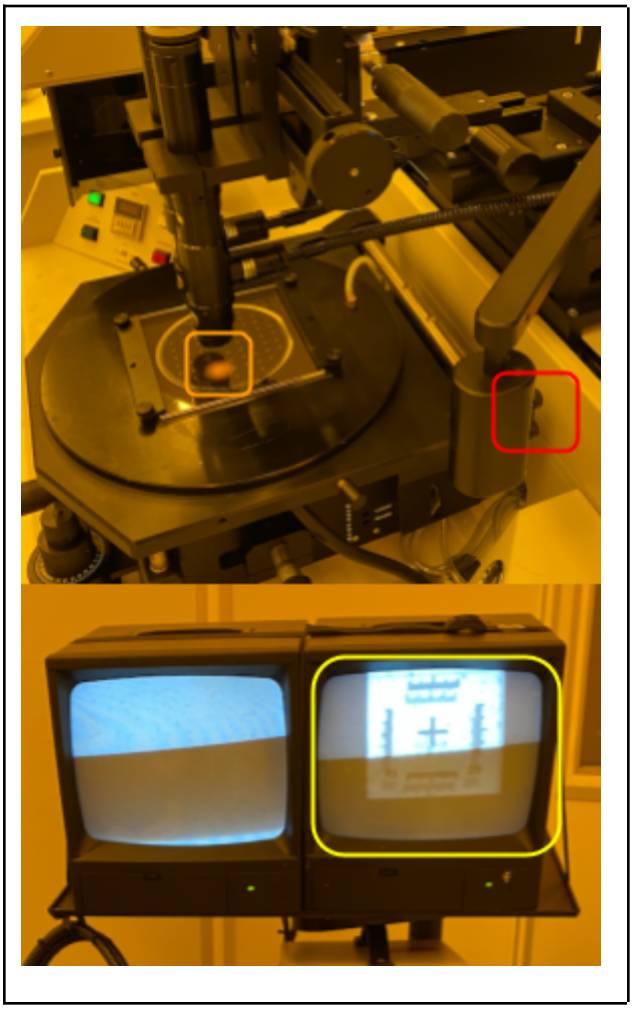
- Flip the switch to ALIGN to move the alignment module over the Mask

Step 5: Turn On the Alignment System



- Turn this Knob to 70 to turn On the Light Source
- Press this Button to turn On the Right Camera Monitor
- Press this Button to turn On the Left Camera Monitor

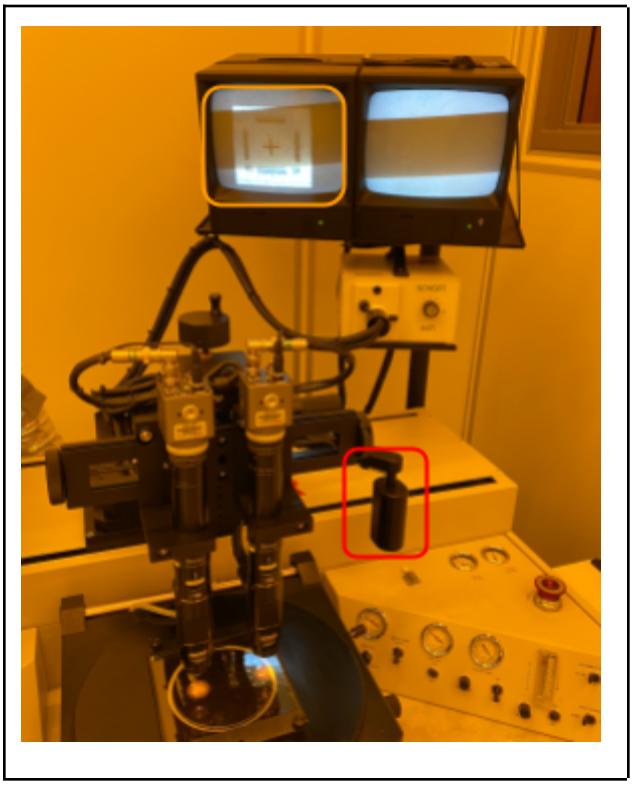
Step 6: Find the Right Alignment Mark



- Press and Hold both Buttons to Move the Cameras
  - Hold Top Button to Move only along Y
  - Hold Bottom Button to Move only along X
- Move the Right Camera Light Beam and Center it on the Right Alignment Mark
- The Alignment Mark should be visible in the Right Monitor

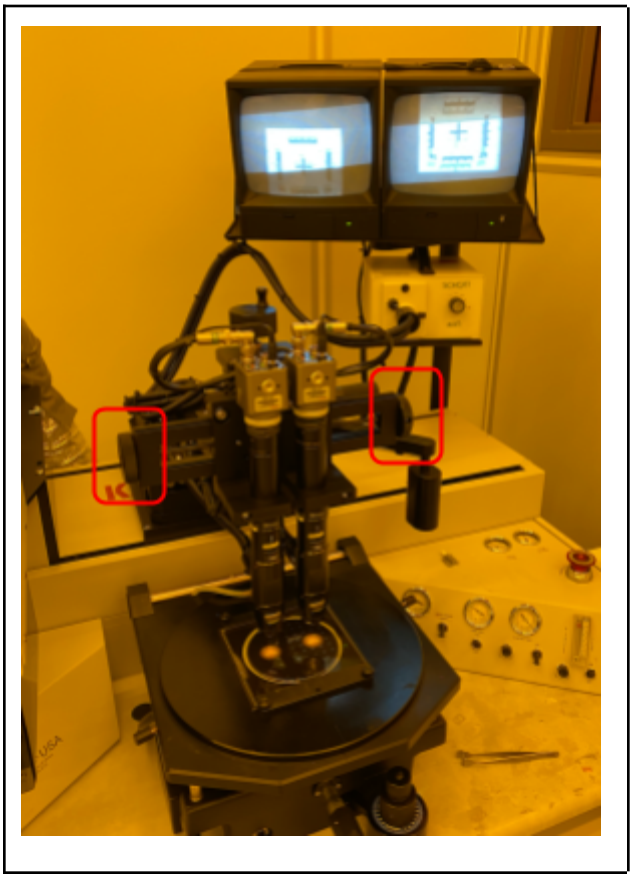
i *The Alignment Mark is a Clear Window (1.2 mm wide) with Dark Markers*

Step 7: Find a Left Alignment Mark



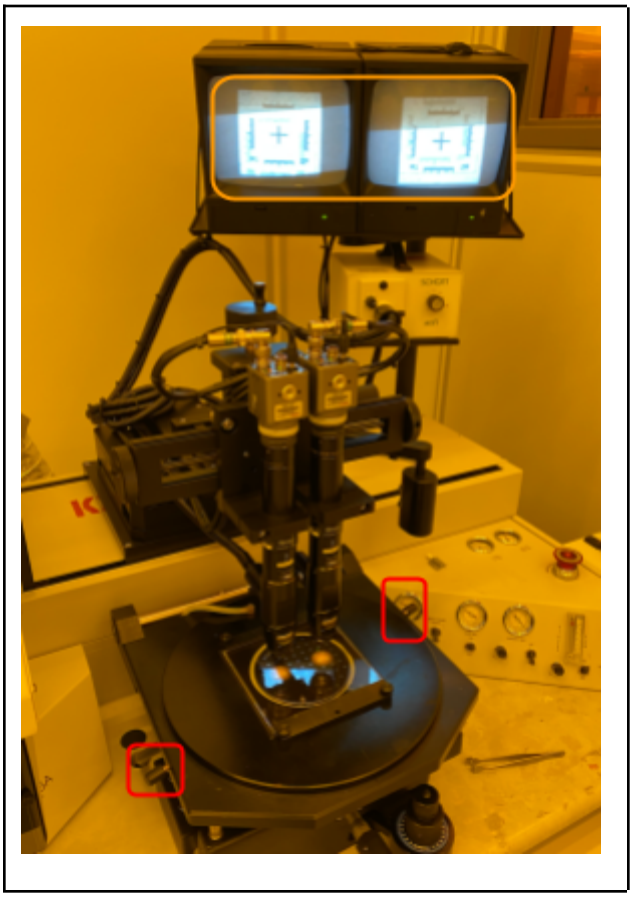
- Press and Hold the Bottom button to Move only along X to
- Move along X until the Left Alignment Mark is visible in the Left Monitor

Step 8: Adjust Camera Spacing to See Both Marks Simultaneously



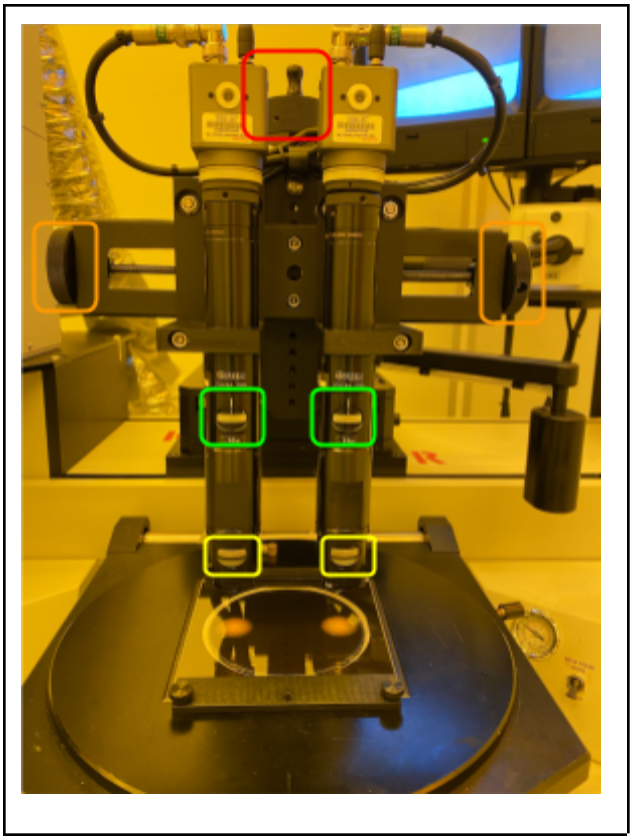
- Adjust these Knobs (2) until both Alignment Marks are visible on both Monitors simultaneously
  - Position the cameras so that you can move both cameras either inwards or outwards to the Alignment Marks

Step 9: Fine Align the Mask Orientation (Optional)



- Loosen these Knobs (2) and Rotate the Mask Plate to Align the Image on the Monitors
- These images are lined up
- Tighten these Knobs (2)

Step 10: Optimize the Alignment System



- Turn this Knob to Focus the Camera to obtain a sharp image
- Turn these Knobs to adjust the Camera Spacing so that it is possible to see both alignment marks simultaneously
- These Rings are used to Focus each Camera separately
- These Rings are used to Adjust the Magnification

- *TV is 5.5” x 7.5” (HxW)*
- *At 1X magnification setting, a 0.5 mm wide cross is roughly 2” on the TV*
- *Thus total magnification for 1X setting is 100X*

Step 11: Fine Align Wafer to Mask

- Turn this Knob to Align both Wafer Marks on the Monitors
- Turn this Knob to Align the Wafer Mark to the Mask Mark along Y
- Turn this Knob to Align the Wafer Mark to the Mask Mark Along X
- Repeat until the Wafer is Aligned with the Mask

Step 12: Establish moderate contact

- Turn the top Z knob counterclockwise to raise the chuck until the Z knob feels loose

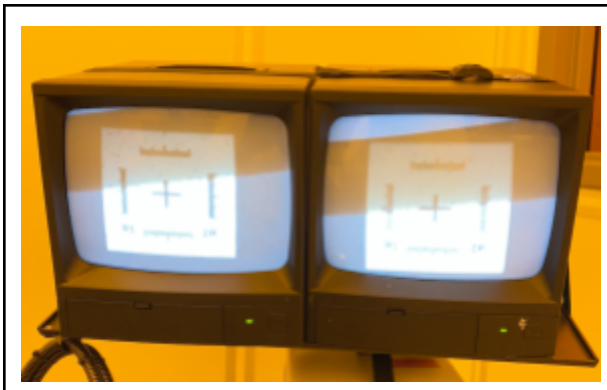
i *Interference patterns will appear when the sample and mask are in contact*

Step 13: Establish vacuum contact

- Flip the switch to turn on CONTACT VAC.
- Wait for the Contact Vacuum pressure to stabilize

i *Contact Vacuum may cause the alignment to shift*

Step 14: Verify Marks are Still Aligned

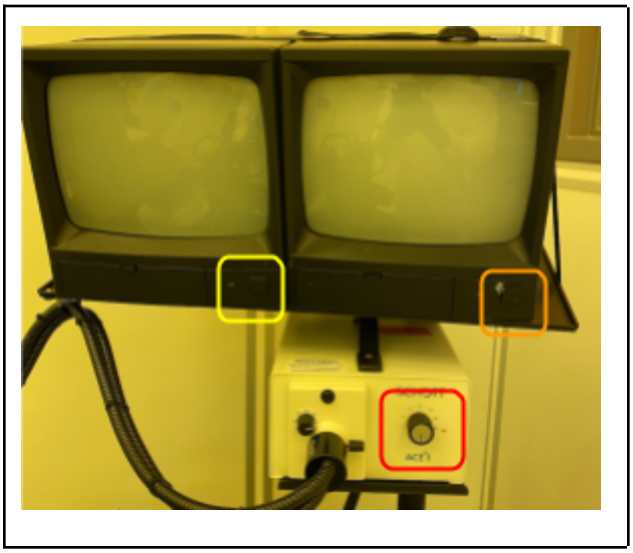


- Verify that the Alignment is still Acceptable

Step 15: Move the Alignment Module out

- Flip the switch to Home to move the alignment module out

Step 16: Turn Off the Alignment System



- Turn this Knob to 0 to turn Off the Light Source
- Press this Button to turn Off the Right Camera Monitor
- Press this Button to turn Off the Left Camera Monitor

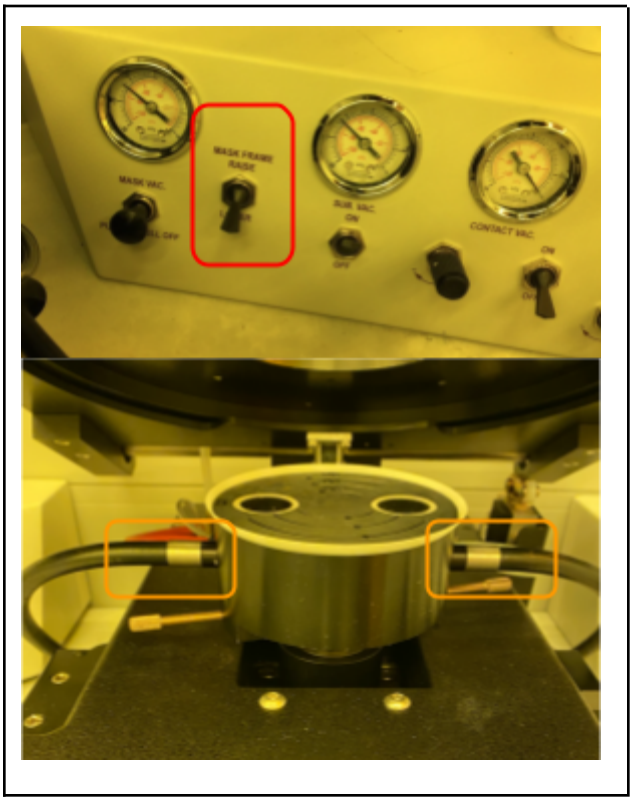
Step 17: Perform and Exposure

Alignment (Backside)

Silicon is transparent to IR light. Backside alignment uses the same camera to capture IR light that is transmitted through the Silicon. The alignment operation is similar to Frontside Alignment.

Step 1: Perform Exposure Steps 1 to 16

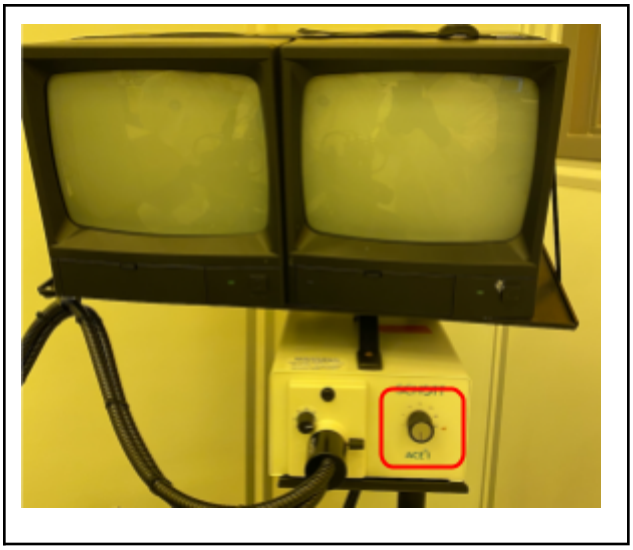
Step 2: Insert IR Fiber to Chuck



- Flip the Switch to RAISE to raise the Mask Frame
- Insert the IR Light Fiber into the Chuck
- Flip the Switch to LOWER to lower the Mask Frame

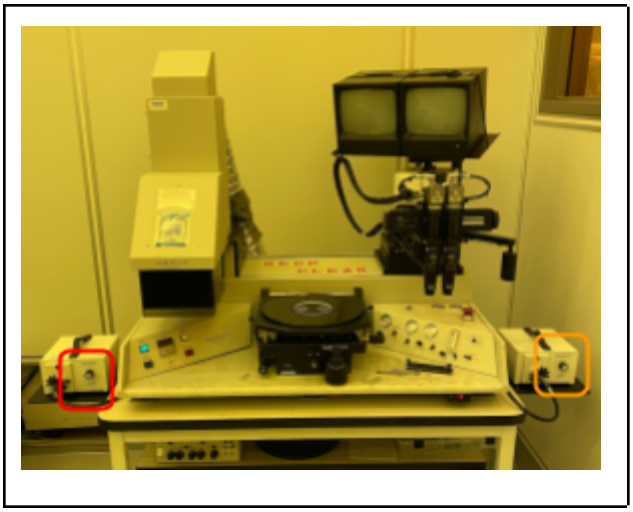
Step 3: Perform Alignment (Frontside) Steps 1 to 10

Step 4: Turn Off the Light Source



- Turn this Knob to 0 to turn Off the Light Source

Step 5: Turn On the IR Light Sources



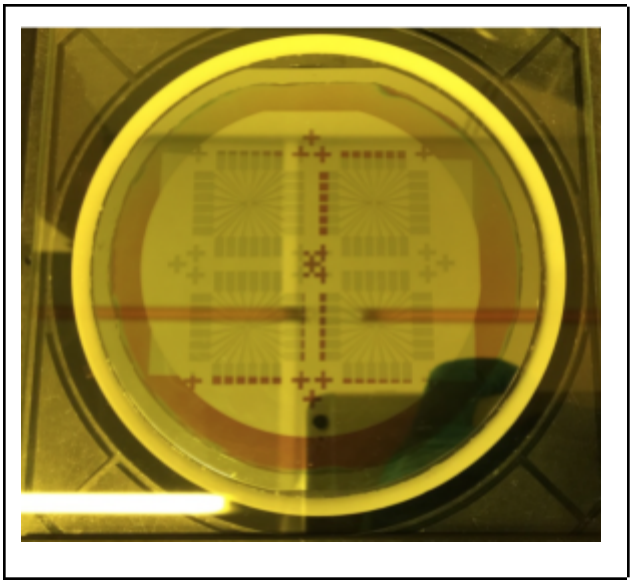
- Turn this Knob (2) to 70 to turn On the Left IR Light Source
- Turn this Knob to 70 to turn On the Right IR Light Source

Step 6: Perform Alignment as Normal

The 3 Modes of Contact

There are 3 modes of contact and they are used for very different purposes. It is extremely useful to be able to identify them.

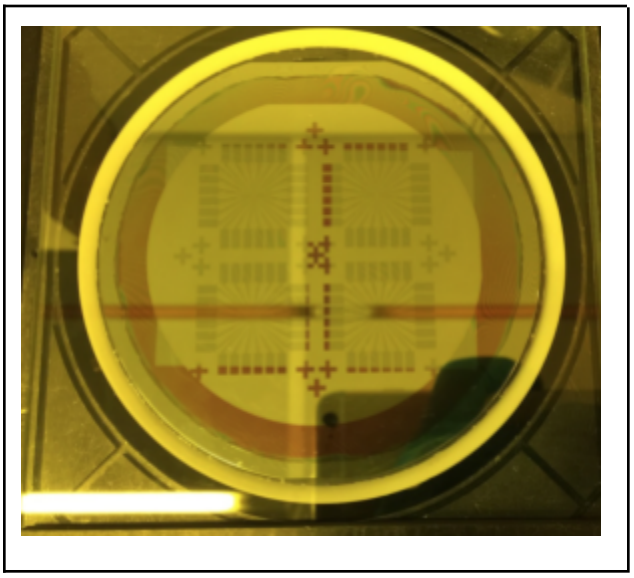
No Contact



- The sample is not in contact with the mask
- The sample can move around freely

i *This mode of contact is used for alignment*

Moderate Contact



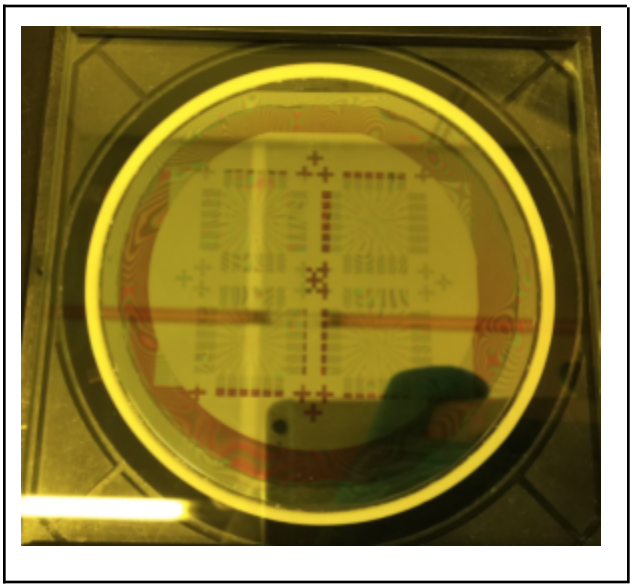
- The sample is pushed against the mask using only the Z knob
- Interference patterns appear

i *Moderate contact is used to planarize the chuck*

i *Moderate contact is the minimum requirement for an exposure*

i *It is not clear whether the there is contact everywhere*

Vacuum Contact



- The air between the sample and mask is sucked out
- Interference patterns are visually stronger

i *Vacuum contact is required for high resolution and consistent exposure*